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# Supplementary Materials for

## Terawatt-scale photovoltaics: Transform the global energy system

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Supplemental information and references for Figure 1

Figure 1: Inflation adjusted utility power price and utility scale PV prices, representing 2017 real dollars for the U.S. and Japan, adjusted by each countries' CPI. German values are in nominal terms as German feed-in-tariff values are more well known. United States: Utility power price (black) and utility scale PV LCOE (blue). Error bars for power price indicate the average wholesale electricity price for the least-cost and highest cost market in a given year, tracked by the U.S. Energy Information Administration. These wholesale markets are: Mass Hub (New England); PJM West (Mid-Atlantic and parts of the Midwest); Indiana Hub (Midwest); Ercot North (Texas); Mid-C (Northwest); NP-15 and SP-15 (Northern and Southern California); and, Palo Verde (Southwest). Wholesale market information is unavailable from 1995-2000, therefore for these years we use the average retail rate for industrial customers; error bars for these years represent the maximum and minimum state average industrial retail rate, excluding Hawaii. Error bars for PV indicate LCOE in New York, NY (high bar) and Phoenix, AZ (low bar). Utility-scale PV system prices are unavailable before 2010, therefore, from 1995-2009 we keep Balance of System costs constant and use module price information from SPV Market Research. Japan: Utility power price (black) and PV LCOE (blue/red) for varying system sizes (5, 6). Germany: Industry power price (black) and feed in tariff prices (2000–2014) followed by PV bidding scheme prices (both blue) for free-standing PV (7, 8).

Supplemental information and references for Figure 2

This estimate for increased electrification is based on combined modeling by Breyer et. al. assuming major electrification in heating (*10*), transportation (*11*), desalination (*12*) and industrial sectors (*13-15*). The solid blue curves suggest multiple scenarios for PV growth, assuming continued near-term market growth using the average annual growth of PV deployments observed between 2008 and 2018 (30%/year). The curves assume that the PV systems are taken out of service after 25 years and that the output degrades by 2% for the first year and 1% each year (relative to the initial performance) after that. These are conservative estimates consistent with earlier Terawatt Workshop modeling (Ref. 1 main text). Continuous 30%/y growth over several decades would result in capacity far exceeding world need, so the deployment growth rate was set to 2%/y starting in 2028, 2030, or 2032 respectively for the three cases. Electricity and capacity are correlated by assuming a current (constant) global average yield of 1370 kWh/kWp annually. This relationship reflects an average yield and changes with time, reflecting the available solar irradiation, mounting configuration, size of inverter, whether the system was deployed part way through the year, etc. The WEO 2018 predicts this ratio to change from 1370 kWh/kWp in 2025 to 1620 kWh/kWp in 2040.

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